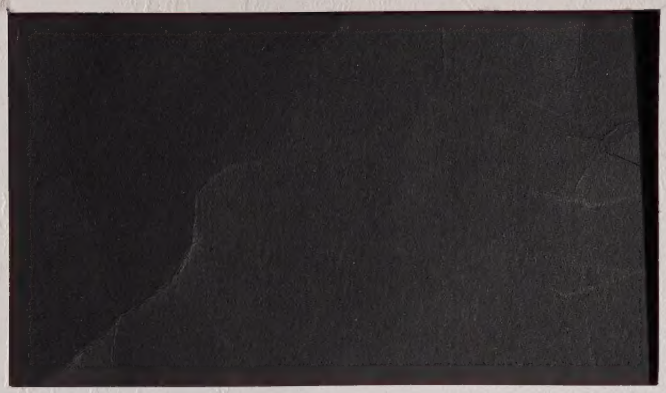

E-H RESEARCH LABORATORIES, INC.
163 ADELINE STREET · OAKLAND, CALIFORNIA 94607

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BOB WARHOLA
AD-24

MODEL 5112
PULSE AMPLIFIER

E-H RESEARCH LABORATORIES, INC.
163 ADELINE STREET • OAKLAND, CALIFORNIA 94607 • (415) 834-3030 • TWX-910-366-7258
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SECTION 1
CHARACTERISTICS

1-1 GENERAL

The E-H Model 5112 Pulse Amplifier is a general purpose instrument that provides a negative output pulse, which is continuously variable from 150 volts to 400 volts, when terminated into 50 ohms. Output risetime is 25 nanoseconds, or less, while falltime is 20 nanoseconds, or less; when driven by a positive pulse with rise and fall times of less than 10 nanoseconds.

Duty factor capability is 0.3% at maximum pulse amplitude, with duty factors up to 1.0% possible if output pulse amplitude is decreased.

Model 5112 requires an input drive pulse of positive 55 volts, with a risetime of less than 10 nanoseconds.

WARNING
HIGH VOLTAGE

Extreme caution must be exercised while operating and maintaining this instrument since certain internal and output voltage levels are in excess of 2 kilovolts.

1-2 SPECIFICATIONS

OUTPUT PULSE AMPLITUDE: The output is an AC coupled negative pulse, continuously variable from 150 volts to 400 volts, when terminated into 50 ohms. Amplitudes from 500 volts to 1500 volts may be obtained by terminating the pulse amplifier into a 300-ohm load.

RISETIME: Risetime is dependent upon the amplitude setting. Typical numbers for a 50-ohm resistive load include:

Less than 20 ns at 150 volts
Less than 25 ns at 400 volts

FALLTIME: Falltime, like the risetime, is dependent upon the output amplitude. Typical numbers for a 50-ohm resistive load are:

Less than 15 ns at 150 volts
Less than 20 ns at 400 volts

WAVEFORM: Pulse top distortion: less than 10% peak-to-peak for all amplitude settings, when terminated into a 50-ohm resistive load. Pulse top droop: less than 6% at 400 volts, with 1μs pulse width. With a pulse width of 3μs, the droop is typically 12%.

DUTY FACTOR: The duty factor at maximum pulse amplitude is 0.3%. A higher duty factor of 1.0% may be obtained at 150 volts. Automatic limiting prevents overload.

PULSE WIDTH: Minimum pulse width is 50 nanoseconds and is determined by the operating frequency and duty factor.

INPUT DRIVE REQUIREMENTS: To obtain maximum pulse amplitude, a positive 55 volt drive pulse with a risetime of less than 10 nanoseconds is required. Peak-to-peak pulse top distortion should be less than 5%. $Z_{in} \cong 62$ ohms, shunted by 140 pf.

OPERATING MODE: STANDBY and OPERATE pushbutton switches are provided on the front panel to allow the pulse to be removed from the output without turning off the instrument. A 60 second initial warm-up period is required.

DIMENSIONS: Rack Mount: 10-1/2" high, 16-3/4" wide (19" front panel), 15" deep.
Weight: 42 lbs. net; 53 lbs. commercial package; 68 lbs. export package.

POWER REQUIREMENTS: 105/125 VAC, 50/60 Hz, 350 W. (May be easily converted to 234 volt operation.)

1-3 APPLICATIONS

The Model 5112 will find many applications in the testing of high voltage devices and circuits, such as: the pulsing of microwave tubes and amplifiers, solid state physics experiments, driving laser diodes and many other high power pulse applications.

SECTION 2
OPERATING INFORMATION

2-1 UNPACKING

Immediately after unpacking the instrument, carefully inspect and evaluate the condition of the shipping container and instrument for evidence of damage that might have occurred during shipment or handling. If damage is noted, the responsible carrier or agency should be promptly notified.

2-2 234 VOLT OPERATION

The internal power supply of the E-H Model 5112 is normally wired for 117 VAC operation. For 234 volt operation, reconnect the primaries of both transformers. Refer to the instrument schematic for proper connections.

2-3 OUTPUT IMPEDANCE

The Model 5112 is designed to operate into a pure resistive load. Loads with appreciable capacitive or inductive components will have a marked effect on the leading and falling edges of the pulse.

2-4 DUTY FACTOR

The duty factor limitation is designed to ensure long life by conservative operation of the output tubes. The overload relay is typically adjusted to give duty factors slightly greater than those specified. Do not defeat the purpose of the overload relay by altering it to obtain higher duty factors. When the duty factor limitation is exceeded, the Model 5112 will switch into its idling or STANDBY condition. Before depressing the OPERATE button, always reduce the driving pulse duty factor to within that specified for the instrument.

2-5 OPERATING CONTROLS AND CONNECTORS

Table 2-1 contains a list of operating controls along with the function of each.

2-6 OPERATING NOTES

a. WARM-UP TIME. The Model 5112 requires approximately 60 seconds for initial warm-up before output operation commences. This warm-up time

will allow the cathodes of the tubes to reach operating temperature before the high voltage is applied to the plates. When the AC power switch is initially turned on, the Model 5112 is in the STANDBY condition. The STANDBY indicator lamp should be on. After approximately 60 seconds of warm-up, depress the OPERATE pushbutton to put the instrument into operation. During operation, the OPERATE lamp should remain on.

TABLE 2-1 MODEL 5112 OPERATING CONTROLS AND CONNECTORS.

ITEM	FUNCTION
POWER	With the line cord connected to a 117 VAC 50/60 Hz power source, turn the power switch to the ON position; the POWER and STANDBY indicators will light.
STANDBY (PUSHBUTTON SWITCH)	Controls the AC line power to the primary winding of the high-voltage transformer. When the STANDBY light is on, AC line voltage is removed from the high-voltage transformer primary.
OPERATE (PUSHBUTTON SWITCH)	OPERATE pushbutton connects the AC line voltage to the primary of the high-voltage transformer, putting the instrument into operation. When the instrument is operating, the OPERATE light is on.
AMPLITUDE	Continuously variable; adjusts output pulse amplitude from -150 volts to -400 volts, into a 50-ohm load.
INPUT (BNC CONNECTOR)	Connector for INPUT drive pulse. Drive pulse requirements are: positive 55 volt pulse with a risetime of less than 10 nanoseconds.
OUTPUT (BNC CONNECTOR)	Connects the OUTPUT signal to the output load.

WARNING
HIGH VOLTAGE

Extreme caution must be exercised during instrument operation since the unterminated voltage of the OUTPUT connector can exceed 2 kilovolts.

SECTION 3
THEORY OF OPERATION

3-1 GENERAL

The E-H Model 5112 is comprised electrically of chassis-mounted sub-assemblies and components that are discussed in the following order: Output, Power Supply and Relay Controls.

3-2 OUTPUT

The output section is comprised of four class C operated pentode amplifiers connected in parallel; and a tube operating as a cathode follower, to provide amplitude control.

Potentiometer R73, in the resistor network of R69 through R73, provides control of the output pulse amplitude by changing the bias voltage on the control grid of tube V5. The cathode of V5 is connected to each of the screen grids of output tubes V6 through V9. By varying the control grid voltage of V5 the screen grid voltage on each of the output tubes is varied, thus controlling the pulse amplitude.

Output tubes V6 through V9 provide a negative 400 volt pulse into a 50-ohm load. The output pulse is coupled to the output connector by capacitor C11. Output tubes V6 through V9 are held at cutoff by Zener diodes CR34 through CR36, when the drive pulse is not present. The cutoff voltage is approximately -50 volts; measured at the control grids with respect to the cathode. Resistor network R77 through R82 provides current to hold the Zener diodes on. When the drive pulse is not present, the control grids of V6 through V9 are held at approximately ground potential through resistor R83.

A +55 volt drive pulse is required to operate the Model 5112. The drive pulse is AC coupled from the input jack to the control grids of tubes V6 through V9 by capacitor C15. When the drive pulse is applied to the control grids of the output tubes, the control grids move to a positive potential with respect to the cathodes, turning the output tubes on hard, thus providing an output pulse. Zener diode CR38 and diode CR39 of the input drive circuit prevent the control grids of the output amplifiers from moving more than approximately +10 V with respect to the cathodes.

3-3 POWER SUPPLY

a. Transformers, Rectifier and Filter Circuit. Power transformers T1

and T2 are factory wired for service with 117 VAC power lines. For 234 VAC service, the primary windings should be reconnected in series. Power transformer T2 has two secondary windings that supply power to the tube filaments. Transformer T1 has one secondary winding, the output of which is rectified by the bridge circuit (CR1 through CR32), then filtered by capacitors C1-C2, and resistors R36-R37. It is then regulated at a positive 2 kilovolts with respect to chassis ground. Resistors R33 through R35, and R38 through R40 function as bleeder resistors for capacitors C1 and C2 respectively. Resistors R1 through R32, in parallel with rectifiers CR1 through CR32, ensure that the breakdown voltage of any one of the rectifiers is not exceeded.

b. Regulator. The power supply is regulated at a positive 2 kilovolts with respect to chassis ground. The pass elements of the series regulator are tubes V1 through V3. The dual triode tube V4, performs as a cathode-coupled differential amplifier. The control grid of one section of V4 is referenced to voltage regulator tubes V11 and V10; any change in the output voltage is sensed at the control grid of the other section of V4 (junction of resistors R53 and R54). R104, which is in series with R53, provides the output voltage adjustment. Zener diode CR33 provides grid bias for the series pass elements V1 through V3.

c. Filament Supply. Transformer T2 has two secondary windings which provide filament power for the tubes. One of the secondary windings supplies filament power for tubes V5 through V9, in addition to the power required for time delay relay K3. This secondary winding is referenced to chassis ground. The other secondary winding provides filament power to tubes V1 through V4. This winding is also connected to the cathodes of the dual-triode V4; thus the filaments of these tubes are floating near the level of the power supply output voltage. The purpose of floating this filament supply at the power supply level is to ensure that the filament to cathode breakdown voltage of V1 through V4 is not exceeded.

3-4 RELAY CONTROLS

a. Duty Factor Limiting Relay. Relay K1 provides duty factor limiting. The normally closed contact of relay K1 is connected in series with the coil of relay K2. When the duty factor limitation is exceeded, the increase in the power supply current activates relay K1, which opens the line providing current to the coil of relay K2. Resistors R102 and R103, which are across relay K1, set the point of duty factor limiting. Capacitor C5, which is also across K1, and resistors R102 and R103 provide time delay before relay K2 switches the instrument to the STANDBY condition.

b. Time Delay Relay. Relay K3 provides time for the tube cathodes to reach operating temperature before the high voltage supply is activated. The time delay relay contact is connected in series with the coil of relay K2. When the relay is cold, the contact is open and consequently the line to the

coil of K2 is open. After the power switch is turned on, the time delay relay requires approximately one minute to actuate. Until actuation occurs, relay K2 is held inoperative.

c. Standby/Operate Relay. Relay K2 controls the application of line voltage to the primary of the high voltage transformer T1. As mentioned above, relay K2 is dependent upon the conditions of relays K1 and K3. When the AC power switch is first turned on, the relay coil of K2 is de-energized and the instrument is in an idling or STANDBY condition. After one minute of time delay, depressing the OPERATE pushbutton switch energizes the K2 relay coil, thus connecting the AC line voltage to the primary of high voltage transformer T1.

If the duty factor limitation is exceeded, the coil of K2 is de-energized by the switching of relay K1, thus putting the instrument in the STANDBY condition. Again, depressing the OPERATE pushbutton energizes K2, putting the instrument back into operation if the duty factor level has been readjusted to within operating limits.

SERVICE INFORMATION

ORDERING INFORMATION

Replacement parts may be ordered through your E-H Representative or from the factory. To be certain that you receive the proper replacement parts, always include the following information with your order:

a. Model Number and Serial Number of the instrument on which the replacement parts will be installed.

b. Circuit or Drawing Reference for which each part is intended.

c. E-H Part Number.

This instrument contains several factory-selected components to ensure optimum performance. In no case should a diode or transistor be replaced with one from a different manufacturer, unless it is on the specific recommendation of E-H.

When replacement parts are necessary, be sure to order through the E-H Customer Service organization. In this way, we can best serve you by providing up-to-date factory recommended parts and service information.

WARRANTY

This instrument is guaranteed to be free from defects in material and workmanship. Our obligation is limited to repairing the instrument should it prove to be defective, upon our examination, within one (1) year after the purchase date. Fuses and batteries are specifically excluded from warranty. Electron tubes, transistors, and diodes are warranted for six (6) months.

For In-Warranty repair of this instrument, contact E-H Research Laboratories, Inc., Customer Service Department, and provide:

a. Instrument Model Number and Serial Number.

b. Full details concerning the nature of the malfunction.

Shipping instructions, or repair information and parts, will be sent to you promptly.

CUSTOMER SERVICE DEPARTMENT, E-H RESEARCH LABORATORIES, INC.

163 ADELINE STREET, OAKLAND, CALIFORNIA - Phone: TE 4-3030, Area Code 415

4-3 PARTS

a. Chassis Deck

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
	Gusset, right side	11282
	Gusset, left side	11850
	Bottom Cover	C11285
	Chassis Deck	11281
T2	Transformer, Power	10575
T1	Transformer, Power	10746
C9	Cap., .01μf, 500v	311-012
C1, 2	Cap., 1.0μf, 5kv	316-055
C11	Cap., .01μf, 3kv	316-057
C6	Cap., 10μf, 2.5kv	316-054
C10	Cap., 1.0μf, 400v	316-056
C7, 13	Cap., 100μf, 150v	316-023
C12, 14	Cap., 1.0μf, 200v	320-011
C15	Cap., 2.0μf, 200v	320-026
L1-4	Choke, .68μh	335-013
CR38	Diode, 1N2620	374-007
CR34, 35	Diode, 1N2958A	374-013
CR37, 39	Diode, 1N914B	376-022
CR36	Diode, 1N3999	374-059
XK1	Socket, Tube 7 pin	495-010
XK3	Socket, Tube 9 pin	495-012
XV6-9	Socket, octal	495-014
	Terminal Board 11 point	484-015
XV5	Socket, tube 12 pin	495-018
K1	Relay, 10K, 2.7ma	584-001
K2	Relay Coil, 6 vac	584-004
R106-109	Resistor, 100Ω, 1/2W, 5%	596-101
R83	Resistor, 100K, 1/2W, 5%	596-104
R84, 87, 90, 93	Resistor, 200Ω, 1/2W, 5%	596-201
R85, 89, 92, 95	Resistor, 2.7Ω, 1W, 5%	597-027
R77-82	Resistor, 110K, 2W, 5%	598-114
	Shield Tube	11280
R69	Resistor, 20K, 2W, 5%	598-203
R70-72	Resistor, 560K, 2W, 5%	598-564
R75, 76	Resistor, 27K, 2W, 5%	598-273
R74	Resistor, 270K, 2W, 5%	598-274
R65-68	Resistor, 470K, 2W, 5%	598-474
R101	Resistor, 62Ω, 2W, 5%	598-620
R96-100	Resistor, 6K, 10W, 5%	610-081
	Standoff	484-001
R86, 88, 91, 94	Resistor, 2.7, 1W, 5%	597-027
	Plate Cap	495-022
V6-9	Tube, 7534	670-026
V5	Tube, 6GE5	670-028
K3	Time Delay Relay, Tube	670-027

b. High Voltage Sub-Chassis

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
	H.V. Sub-Chassis	11286
C3	Cap., cer., .001μf, 6kv	311-030
C4	Cap., elec., 10MF, 150v	316-033
C5	Cap., elec. 500MF, 50v	316-005
CR33	Diode, 1.5W, 150v, 10%	374-009
	Terminal Board, 11 point	484-015
R33-35, 38-40	Resistor, 2 meg., 2W, 5%	598-205
R36	Resistor, 200Ω, 10W, 5%	610-055
R37	Resistor, 500Ω, 10W, 5%	610-057
R41, 44, 47	Resistor, 1K, 1/2W, 5%	596-102
R42, 45, 48	Resistor, 510Ω, 1/2W, 5%	596-511
R43, 46, 49	Resistor, 100Ω, 1/2W, 5%	596-101
R50	Resistor, 200K, 2W, 5%	598-204
R51, 52, 63, 64	Resistor, 100K, 20W, 5%	610-059
R53	Resistor, 100K, 2W, 5%	598-104
R54-56	Resistor, 300K, 2W, 5%	598-304
R57-62	Resistor, 150K, 2W, 5%	598-154
R102, 103	Resistor, 1.3K, 2W, 5%	598-132
R104	Potentiometer, locking 250K	545-012
XV1-3	Socket, Tube 12 pin	495-033
XV4	Socket, Tube 9 pin	495-012
XV10, 11	Socket, Tube 7 pin	495-010
V1-3	Tube 6GE5	670-028
V10, 11	Tube, 5651	670-013
V4	Tube, 12AX7	670-012

c. Terminal Board

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
	Terminal Board	11287
	Bracket	10946
CR1-32	Diode, 1N4005	376-034
R1-32	Resistor, 3.9 meg, 1/2W, 5%	596-395

d. Front Panel Assembly

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
	Front Panel	11233
	Chassis Panel Front	11283
XF1-5	Fuse Post	396-001
DS1	Pilot Lamp Red	510-008
R73	Potentiometer, 250K	550-035
S1	Switch, toggle	630-006
S2	Switch	635-007
J1, 2	Connector, BNC	721-033
R105	Resistor, 100K, 1/2W, 5%	596-104
S3	Switch	635-005
F5	Fuse 2 amp, slo-blo	398-002
F1, 2	Fuse 4 amp, slo-blo	398-004
F3, 4	Fuse, 2 amp	398-014
	Chassis Mtg. Brackets	405-003
	Knob, Small	443-009
	Handles, Black Anodized	425-007

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
e. Rear Panel Assembly		
	Rear Panel	11284
J101	Power Receptacle	700-018
J102, 103	Receptacle, AC convenience	700-032
	Power Cord	786-001

REVISIONS						
ISSUE	REVISION	DATE	DRAWN	CHK'D	APPV'D	E.O.
A	ORIG. RELEASE	3.3	S.R			
B	R51,52,63 & 64 WERE 10W	3-1-66	RBW			6639
C	CORRECTED VOLTAGE	8-26-66	RBW			DCN 34

PROPRIETARY INFORMATION
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T1
10746

RED 2600V RMS
GRN 2200V
YEL 1800V
BLK

8 X IN4005 EACH LEG
8 X 3.9M 1/2W EACH LEG

CR1-CR4 CR5-CR8 CR9-CR12 CR13-CR16
CR17-CR20 CR21-CR24 CR25-CR28 CR29-CR32

R1-R4 R5-R8 R9-R12 R13-R16
R17-R20 R21-R24 R25-R28 R29-R32

R36 200 10W
R35 2M 2W
R34 2M 2W
R33 2M 2W

OPERATE
F5 2ASB SLO-BLO
STANDBY
P & B 6A-14A
K2
S2 OPERATE
S3 STANDBY
K3
AMPERITE #6 NO 60T 6.3V A.C. 60SEC. DELAY
T2 B-10575
6.3V 6A
8A TO V5 THRU V9
6.3V 4A TO V1 THRU V4
P & B # SM5LS

A.C. FUSES
J101 117V AC
F1 4ASB
POWER
SLO-BLO
F2 4ASB
S1
DS1
ON
R105 100K
F3 2ASB
F4 2ASB
J102
J103

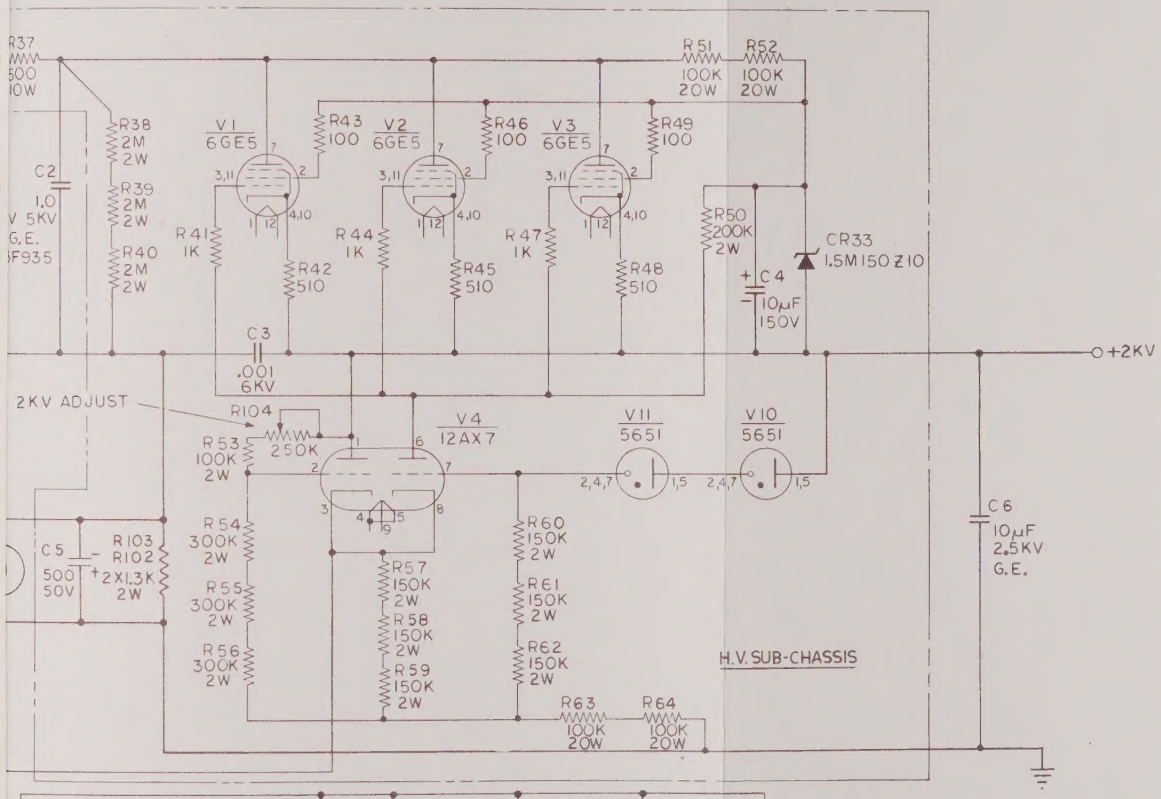
R67 R68 470K 2W 470K 2W
R66 470K 2W
R65 470K 2W
V5 6GE5
+ 2KV
R69 20K 2W
R70 560K 2W
R71 560K 2W
R72 560K 2W
R73 250K
R74 270K 2W
AMPLITUDE
R77 R78

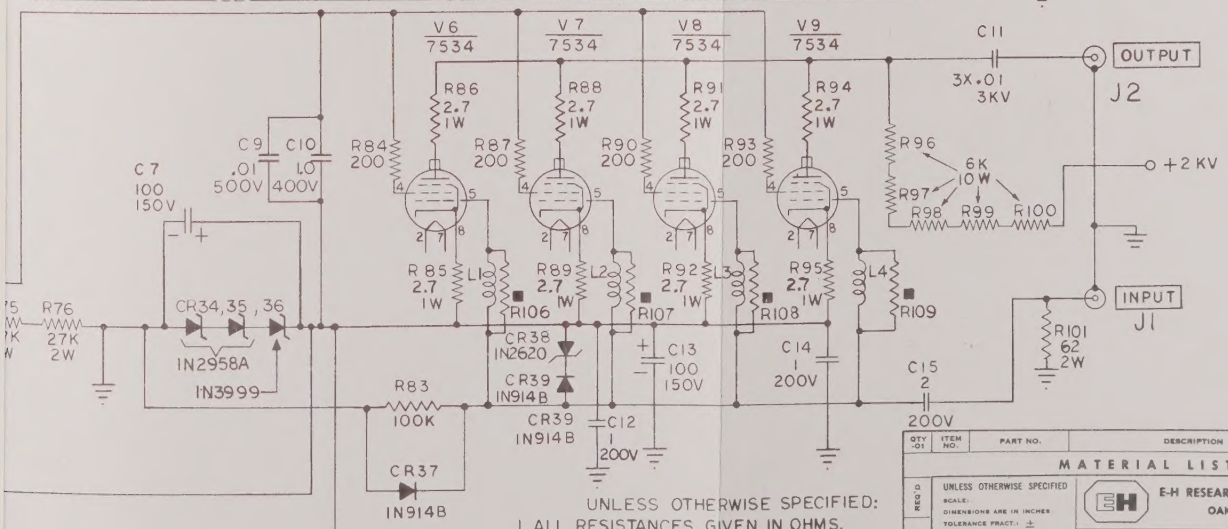
R109	C15	CR39

TITLE: PULSER SCHEMATIC

D-11279 C

SHEET NO. 1 OF 1





UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTANCES GIVEN IN OHMS.
2. ALL RESISTORS ARE ½ W, 5%
3. ALL CAPACITANCES GIVEN IN MICROFARAD
4. L1 THRU L4 ARE .68μh.
■ R106 THRU R109 ARE 100Ω

QTY -01	ITEM NO.	PART NO.	DESCRIPTION	SCHEMATIC OR SPEC. REF

MATERIAL LIST

REQ'D | USED ON | NEXT ASS'Y | VAR.

UNLESS OTHERWISE SPECIFIED
SCALE:
DIMENSIONS ARE IN INCHES
TOLERANCE FRACT.: ±
DECIMALS: ±
ANGLES: ±
HOLE DIAMETERS: ±
MACHINED SURFACES: √
BREAK s DEBURR SHARP EDGES
DO NOT SCALE DRAWING
FINISH:

E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE:
MODEL 5112
PULSER SCHEMATIC

	INITIALS	DATE	I.D. NO.	DWG. NO.	ISSUE
DRAWN	G.B.	10/21/62		D-11279	C
CHK'D		10.28.66			
APP'D		5/5/65			

SHEET NO. 1 OF 1 SHEETS

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